Statement Testimony of

The Honorable Zachary J. Lemnios
Director, Defense Research and Engineering

Before the United States House of Representatives
Committee on Armed Services
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Introduction

Good afternoon Madam Chairwoman, Ranking Member Miller. I am pleased to be here today on behalf of the dedicated men and women working in the Department of Defense, Research and Engineering (DDR&E) enterprise who discover, develop, engineer, and field the critical technologies for our Service Members, and civilians deployed in the defense of our Nation. I would like to thank the members of Congress for your continued support of the Department's science and technology (S&T) program and our broader research and engineering (R&E) program[1]. Your steadfast support has allowed the Department to field technologically-based military capabilities that are unmatched anywhere in the world and provide the capability edge upon which our Soldiers, Sailors, Airmen and Marines rely.

I am also honored to be joined today by leaders of the Department's S&T organizations who will provide testimony in support of their individual S&T efforts: Dr. Tom Killion from the Army, Rear Admiral Nevin Carr from the Navy, Dr. Steve Walker from the Air Force, and Dr. Regina Dugan from the Defense Advanced Research Projects Agency (DARPA). Their leadership of the DoD S&T community is critical to the success of our forces to meet today's challenges and to prepare for the future.

I am here today to describe the FY 2011 President's Budget Request (PBR-11) for science and technology, to show how prior investments have maintained our technological edge and to show how the FY 2011 investment will continue to provide critical capabilities for our Nation's security.

Innovation, Speed, and Agility

We are in a period of change. Innovation, speed and agility have taken on greater importance to our efforts given today's globalized access to knowledge and the rapid pace of technology development. For decades, the US military's dominant operational capabilities were largely due to the continued development and delivery of superior technology by the defense research and engineering enterprise. This enterprise has successfully worked in the past with the university research community and the defense industrial base to develop the underpinning technologies for stealth aircraft, precision weapons, reconnaissance and positioning satellites, lasers, advanced lightweight materials, and the internet.

While effective against linear threats, this long-term development model is not well-suited for the new security environment which requires adaptation, innovation, and delivery on the timeline of weeks and months. Dominant operational capabilities in the future will be underpinned by weapon systems that can rapidly adapt to changing environrments. To meet the demands of near-term and future system challenges, the

[1] Science and Technology (S&T) is defined as the sum of basic research (6.1), applied research (6.2) and advanced technology development (6.3). Research and Engineering is S&T plus Advanced Component Development and Prototyping (6.4). Basically both S&T and R&E are activities that occur before initiation of formal acquisition programs.

Department is opening new avenues of innovation and fundamentally new research and engineering approaches that result in a steady flow of credible technology options. We are working to engage a deeper pool of private sector talent and are encouraging a new generation of young scientists and engineers to pursue career paths in support of our Nation's security.

Renewed Role of S&T

As I look to the challenges facing us I see a renewed role and increased importance for S&T in support of our Nation's defense. This has been clear from my very first day in office. This new focus was informed by the broader range of challenges outlined in the Secretary of Defense (SecDef) April 6, 2009 Defense Budget Recommendation Statement[2] and further highlighted by the numerous briefings I received prior to my Senate confirmation hearing.

The SecDef has been clear about his three principal goals: reaffirm our commitment to take care of the all-volunteer force; rebalance the Department's programs to institutionalize and enhance our capabilities to fight the wars we are in today and the scenarios we are most likely to face in the years ahead, while at the same time providing a hedge against other risks and contingencies; and reform how and what we buy, meaning a fundamental overhaul of our approach to procurement, acquisition, and contracting. To meet the SecDef's goals, the DDR&E enterprise is pursuing solutions across the entire spectrum, from technology discovery to delivery of capabilities, and most importantly we are striving every day to rapidly deliver these capabilities to our men and women in uniform.

I view outreach as an important element of our strategy to implement the SecDef's goals. During my first months as DDR&E, I made it a priority to visit all of the Combatant Commanders (COCOMs) to understand their near-term priorities and their future needs. I heard some common themes from our discussions and the need for immediate solutions. Each COCOM asked for the 80% solution in the field today, rather than 100% solution years from now. The Commanders asked for my help in finding ways to innovate in the field, and we did this by coupling our S&T workforce with the users in the field to provide immediate feedback to our rapid prototyping and formal acquisition programs. In fact, there are now over 70 embedded science and technology advisors that provide direct feedback and assessment of ongoing development programs. These are our technology scouts and transition agents in the field.

During my visit to Special Operations Command (SOCOM) last fall, I was fortunate to meet Senior Chief Petty Officer Chris Beck who works with the SOCOM S&T advisor. Chris is a remarkable individual and has spent most of his 20 year of service as a Navy SEAL operator forward deployed, most recently in Afghanistan. He

[2] U.S. Department of Defense, *Defense Budget Recommendation Statement as Delivered by Secretary of Defense Robert M. Gates, (Arlington, VA),* http://www.defense.gov/Speeches/Speech.aspx?SpeechID=1341 (Apr. 6, 2009).

brings a wealth of knowledge to both the S&T and the acquisition efforts. Chris bridges the gap between the capability providers and the operators and ensures systems are relevant to the current fight and operate properly in the most challenging environments. One of SOCOM s most interesting concepts is a deployed rapid prototyping capability, which allows design, fabrication, modification, and testing of components and systems in the field. The first capability in terms of personnel and equipment is currently in Afghanistan, and in April, the first Mobile Technology Complex will deploy. This will enable operators to repair and upgrade deployed systems in hours and days, vice weeks and months. The importance of this connection between the warfighters and the S&T enterprise cannot be understated; in fact, I intend to grow and strengthen these connections.

An Integrated S&T Enterprise

The DDR&E enterprise encompasses a remarkable pool of talent and resources. Our footprint includes 67 DoD laboratories dispersed across 22 states with a total workforce of 61,400 employees; 35,400 of whom are degreed scientists and engineers, who publish thousands of reports and peer-reviewed technical papers. We operate 10 Federally Funded Resarch and Development Centers (FFRDCs), 13 University Affiliated Research Centers (UARCs) and 10 Information Analysis Centers (IACs) across critical disciplines for the Department. These institutions enable the Department to connect with top technical talent across the Nation in fields ranging from cyber security to ballistic missile defense to advanced microelectronics and more. They provide objective system engineering, objective red team assessments, gold standard test and evaluation, deep dive technical talent and innovative paths for rapid prototyping

We also enjoy a strong relationship with industry and academia through a variety of programs designed to foster collaboration, including the Small Business Innovation Research (SBIR) program; Cooperative Research and Development Agreements (CRADA) and the Joint Reserve Unit (JRU) within DDR&E. In fact, in FY 2009, the Department issued approximately 2000 SBIR Phase 1 awards (as a result of 12,000 proposals), and approximately 900 Phase 2 awards and engaged in almost 3,000 CRADAs across a broad industrial base. Each of these is an avenue of innovation and a transition path to bring ideas into the Department and transition concepts developed in DoD Laboratories to commercial use. As part of this engagement, the Joint Reserve Unit (JRU) provides DDR&E with a unique surge capability and talent resource that extends the Department’s reach into the public and private sector. The JRU's team of joint service reserve personnel create a "knowledge network," facilitating sharing and capture of emerging, innovative, and disruptive technologies, in order to maintain the U.S. military's preeminent capability advantage. With strong ties into the science, technology, engineering, venture capital and finance commercial sector, the JRU provides us with fresh perspectives through dynamic and innovative thinking while augmenting our resources for emergent national security issues.

Lastly, the Department continues to have deep connections with our Nation's universities and colleges. Across the full S&T portfolio, we support over 5,000 undergraduate and graduate students through our research programs, Science, Mathematics And Research for Transformation (SMART) scholarship-for-service program and our National Defense Science and Engineering Graduates (NDSEG) graduate fellowship program. The Department of Defense, funds about 11 percent of all full time science and engineering graduate students supported by the Federal government, and does so in all 50 states.

We are in a unique position to leverage this "Research Triple"[3] of industry, academia and the DoD S&T enterprise engaged to advance new technical ideas in response to an emerging set of National security challenges. This successful model was demonstrated by the SEMATECH, the Semiconductor Research Corporation and the subject of much analysis validating the business and transition leverage.[4] It draws upon the core basic and applied research methodologies of academia and the experience and successes of the commercial marketplace to rapidly transition innovative research results to both commercial and military applications use.

Coordination among our S&T organizations is strong and vibrant. In January of this year, I hosted a 3-day Reliance 21 Science and Technology Strategic Overview meeting along with the S&T executives from the Services and Agencies to synchronize efforts across the Department's $12.0 billion S&T investment. The objective of Reliance 21 is to integrate ideas and execution paths for a broad range of technology concepts across the Department. This meeting included representatives from DARPA, the Services, the Defense Threat Reduction Agency (DTRA), the Joint IED Defeat Organization (JIEDDO), the Missile Defense Agency (MDA) and Nuclear & Chemical & Biological Defense Programs.

DDR&E Fast-Ramp Initiatives

Innovation, speed, and agility are the new hallmark characteristics of the DDR&E enterprise. For example, I launched a set of short-deadline, fast-ramp initiatives to identify solutions to the challenges I learned during my initial meetings with the COCOMs and subsequent discussions with the DoD Joint Staff. We examined cyber; computer science; electronic warfare; tagging, tracking and locating; helicopter survivability; applied advanced mathematics; development of a rapid capability toolbox; and deployable force protection. Each study was tasked to develop a thorough understanding of the technical challenge and the emerging threats, to recommend mitigating capability concepts to mitigate the challenge and to identify and also devise a credible technology transition strategy. We captured ideas from across the S&T enterprise, industry and academia. The reports were delivered in late summer and early

[3] Zachary J. Lemnios and Alan Shaffer. 2009. *The Critical Role of Science and Technology for National Defense.* Computing Research News, Vol. 21/No. 5: http://archive.cra.org/CRN/articles/nov09/defensetech.html

[4] William B. Bonvillian, "Power Play, The DARPA Model and U.S. Energy Policy," *The American Interest* II(2):39-48, 2006

fall and were used to confirm ongoing efforts and prioritize new S&T initiatives, which were included in the PBR-11.

Guided by this approach, PBR-11 is structured as a portfolio of technologies, capabilities and engineering efforts to rapidly identify, develop and field capabilities; to streamline the acquisition process; to understand the current and future landscape; and to place a premium on innovation throughout. During the PBR-11 budgeting process, the DDR&E staff was actively engaged with the Office of the Undersecretary of Defense for Policy while creating the 2010 Quadrennial Defense Review (QDR)[5]. The QDR released in February by Secretary Gates has many S&T threads which provide further reinforcement for the critical efforts of our entire R&E enterprise.

Guidance for S&T Activities

The QDR outlined a series of recommendations aimed at rebalancing America's Armed Forces to better enable success in missions critical to protecting and advancing the Nation's interests. The QDR also recognized the need to strengthen our technology and industrial bases to maintain our technological edge in a dynamic, diverse and evolving threat environment. The 6 mission areas were identified as follows:

- Defend the United States and support civil authorities at home
- Succeed in counterinsurgency, stability, and counterterrorism operations
- Build the security capacity of partner states
- Deter and defeat aggression in anti-access environments
- Prevent proliferation and counter weapons of mass destruction
- Operate effectively in cyberspace

In August 2009, the Office of Science and Technology Policy (OSTP) and the Office of Management and Budget (OMB) jointly released priorities to be supported through the FY 2011 Budget.[6] This guidance was instrumental in development of the FY 2011 submission and reflected in an increase of 9.5% (or just over $200 million) in basic science funding. This additional funding has been dispersed to the Services and agencies to support Administration priorities within the fundamental sciences. It will address our hardest problems with new, transformative capabilities that come from the new tools of basic research. Examples of increased efforts in basic research include: advanced nanoscale manufacturing; ultra-short lasers to explore the new physics and chemistry phenomena far from equilibrium; computational cognitive science; cyber security; quantum information science; and advanced materials for counter-improvised explosive devise applications.

[5] U.S. Department of Defense, *2010 Quadrennial Defense Review, 2010.* http://www.defense.gov/QDR/images/QDR_as_of_12Feb10_1000.pdf

[6] The White House, Washington DC, August 4, 2009 M-09-27 Memorandum for the Heads of the Executive Departments and Agencies from Peter R. Orszag, Director, Office of Management and Budget and John P. Holdren, Director, Office of Science and Technology Policy

DDR&E Imperatives

To focus the organization in support of the immediate and future needs of the Department of Defense, I introduced 4 Imperatives:

1. Accelerate delivery of technical capabilities to win the current fight.
2. Prepare for an uncertain future.
3. Reduce the cost, acquisition time and risk of our major defense acquisition programs.
4. Develop world class science, technology, engineering, and mathematics capabilities for the DoD and the Nation.

Accelerate Delivery of Technical Capabilities to Win the Current Fight

COCOMs want results today. They want the S&T enterprise to deliver an 80 percent solution today versus a 100 percent solution two or more years from now. While typical technology transitions have been counted in years and decades, militarily-useful solutions are needed in weeks and months. To satisfy priority operational needs in a timely manner, we are working to deliver capabilities on par with commercial cycle times and costs. The first DDR&E Imperative specifically addresses this need and maintains the S&T focus on the innovative fielding of capabilities. Examples of current and future activities in support of this Imperative are:

Joint Concept Technology Demonstrations (JCTDs)

The role of the JCTD Office is to speed the discovery, development, and delivery of technology and concepts for sustained joint military capabilities or, more simply put, to operationalize innovation faster than ever. Each JCTD project exploits mature and maturing technologies and introduces new operational concepts to solve important military problems and facilitates transition of these new capabilities from the developers to the users.

Earlier this year the JCTD process was restructured based on inputs from the Joint Staff, the Vice Chairman of the Joint Chiefs of Staff, the COCOMs, the Undersecretary of Defense (Acquisition, Technology and Logistics) (USD(AT&L)), and congressional staffers to shorten the time from idea to first proof of concept to 12 months. The new process works on quarterly cycles (3 month) for new starts, and for review of ongoing projects. These quarterly decision and review boards are chaired by the DDR&E and co-chaired by the Deputy, J8 from the Joint Staff. Every new start will have a clearly identified one-year deliverable to assess progress and to provide the Joint Requirements Oversight Council (JROC) a demonstrated capability prior to requirement validation. Our legacy process averaged 3 to 4 years per program, this accelerated process is designed to have more demonstrations earlier with a clearly-defined down select process at the one-year point.

The coupling of the JCTD process with the Joint Experimentation (JE) effort was initiated this year. The JE program validates the highest priority Warfighter challenges from the COCOMs and develops operationally relevant experimentation opportunities to

assess current and future tactics, techniques and procedures. When able, we are using these experimentation venues to test our prototype JCTD systems with actual service members operating in threat-representative scenarios. The synergy between both these programs will optimize the doctrine and capabilities delivered to our warfighters.

Helicopter Survivability Task Force (HSTF)

As I mentioned earlier, one of my first initiatives upon arrival, was to launch a set of quick-turn studies. The HSTF was one such study, with the objective of identifying, demonstrating and integrating capabilities to mitigate the threat of small arms fires and safety risks to helicopters operating in Iraq and Afghanistan. Of these candidate programs, the Helicopter Alert and Threat Termination - Acoustic program (HALTT-A), was in early stage development by DARPA and is more fully discussed in the testimony submitted by DARPA. DDR&E assisted in the resourcing of the follow-on testing, and airworthiness certification of an operationally-representative system configuration for the 16 acoustic sensors, associated computers and pilot displays. This fast track integration and testing will shorten the delivery timeline by years.

Joint Rapid Acquisition Cell

The Joint Rapid Acquisition Cell (JRAC) tracks, coordinates and addresses Joint Urgent Operational Needs (JUONS). JUONS are identified by COCOMs and are usually capability gaps that result in casualties or potential loss of life. The JRAC has the ability to draw on the capabilities developed elsewhere within the Department and employs Rapid Acquisition Authority to obtain the capabilities identified by the Warfighter.

A good example of the JRAC's ability to move quickly through the acquisition process is the Persistent Ground Surveillance System (PGSS). The PGSS was an offshoot of a JCTD project, which took less than 60 days to get started; it provides a low-cost alternative for an integrated, intelligence surveillance reconnaissance (ISR) system. PGSS provides persistent overwatch, threat detection, and communications relay for our forward operating bases. The initiative directly supports coalition forces in Afghanistan, and accelerated from start-up to initial deployment in 6 months, with strong Army partnership and Army sustainment strategy.

Rapid Reaction Technology Office

The Rapid Reaction Technology Office (RRTO) has conducted a number of projects to develop tools, models and assessments to support the policy, strategy, and operational strategic communications community within DoD and the interagency. RRTO fosters research and development of special capabilities, and other non-kinetic capabilities from a "whole-of-government" perspective, by forming partnerships with Office of the Undersecretary of Defense (Policy), the State Department, Office of the Undersecrtary of Defense (Intelligence), the Departments of Homeland Security and Justice, and other non-governmental organizations such as the US Institute for Peace. Two projects are highlighted below:

The Pakistan and Afghanistan Rich Contextual Understanding (PAKAF RCU) Strategic Multi-layer Assessment: The purpose of the PAKAF RCU project is to provide the International Security Assistance Force (ISAF) Commander with a rich contextual understanding of multiple dynamic environments, situations, locations, messages, and people in the PAKAF area. General McChrystal specifically asked for support from PAKAF RCU late last year. The overall project is limited in scope to 16 districts in three provinces in Afghanistan (Kunduz, Paktika and Helmand) and 10 districts in Pakistan. It consists of six interrelated components: 1) development and population of classified and unclassified, annotated and searchable data libraries, 2) "all-district" data generation and multi-method assessment efforts, 3) a "deep dive" on Helmand province, 4) response to "40 Questions" directed by Major General Flynn (ISAF), 5) production of "rich contextual" materials, and 6) development of an RCU-Vis software application containing easily accessible and searchable information on the sixteen districts in Afghanistan and Pakistan. The project depends on a variety of methods for data collection, including polling, crowd sourcing, audience analysis and agent-based modeling.

The Afghanistan Virtual Science Library (AVSL): The project's goal is to have workers in the Afghanistan civilian population gain the skills and resources needed to support stability and security operations, preserve existing intellectual capital, encourage new professional relationships, and support a traditional source of moderate leadership in Afghanistan -- engineers and scientists. The U.S. Civilian Research and Development Foundation (CRDF) is managing the pilot program to provide students and researchers at the University of Kabul with access to up-to-date publications and knowledge resources in a cost-effective and accessible form. This will establish a baseline for implementation of a nationwide virtual science libary adapted for Afghanistan's needs.

Prepare for an Uncertain Future

In preparing for an uncertain future, a comprehensive strategy for defense research and engineering efforts becomes ever more critical. Investments in basic and applied science, technology development and transition, and in-house research capability are critical enablers of technological superiority, and by extension, operational advantage.

DARPA is central to our entire S&T effort. It is the innovation engine of the Department, with the latitude to attract the best scientific talent, and engage them on some of our most challenging problems. The high payoff technologies from DARPA projects have been the foundation of many capabilities and major weapons systems. The ability to look ahead of the technology curve to identify future challenges and high-payoff research areas that may not yet be recognized as critical by the larger defense community, and which will enable future warfighter capabilities, is a necessity. In this vein, the goal of DDR&E is to serve as an unbiased broker in setting the pace and priorities for research and engineering efforts across the Department in order to create options to shape the future, rather than react to it. Some examples of DDR&E research areas are listed below.

Airborne Laser (ABL)

An area where we have demonstrated breakthrough advances is in airborne laser technologies. In January of this year, the Missile Defense Agency demonstrated the first ever tracking and low power laser engagement of a boost phase target in the pacific missile range from the 747 Airborne Laser (ABL). In February this program demonstrated a full power boost phase intercept. To continue the development of future airborne laser concepts and capabilities, the ABL may serve as an airborne directed energy test-bed for the Department dependent on the results of an ongoing study directed by Secretary Gates.

Human, Social, Cultural, and Behavioral (HSCB) Modeling

The Human Social Culture Behavior (HSCB) Modeling program utilizes "soft power" derived from leveraging the soft sciences to provide innovative solutions. The program's ultimate goal is to put model-based tools in the hands of DoD personnel supporting intelligence analysis, operations analysis and decision-making, training, and joint experimentation. The HSCB Modeling program has engaged extensively with COCOMs and other operational users, leading to direct support to our Warfighters in Afghanistan and other operational objectives. Program investment has supported deployed users with greatly enhanced visualization capabilities, creation of a toolset to incorporate HSCB modeling factors into campaign planning for U.S. Army Training and Doctrine Command (TRADOC) and U.S. Army Special Operations Command (USASOC), and tools for determining regional stability.

Some current HSCB modeling projects are: The University of Chicago's Modeling Strategic Contexts, which supports the analysis of international conflicts by providing rich models of strategic context; Eastern Michigan University's Variations in Islamic Fundamentalism, designed to understand the factors influencing religious extremism and support for secular politics, gender equality, and national identity; Los Alamos National Laboratory's Simulation of Opium Supply Chain, which is developing models of adaptive decision-making in illicit cross-border supply chains; and TRADOCs Irregular Warfare Analytic Capabilities project developing methods, models, and tools (MMT) representing the Irregular Warfare (IW) operational environment.

Medical R&D and the Wounded Warrior Program

About 18 months ago, the Department conducted an extensive review of medical research and development. This review used the Joint Force Health Protection Concept of Operations to focus on key Wounded Warrior issues including Traumatic Brain Injury (TBI), Post Traumatic Stress Disorder (PTSD), prosthetics, and eye injury. As a result funding for this initiative was increased by nearly $500 million per year in the base Defense Health Program budget in FY 2010—a commitment that continues through FY 2011 and beyond. This initiative is making remarkable progress in such areas as understanding and mitigating brain injury and developing advanced prosthetics that restore greater functionality to our brave warriors.

The Department's medical R&D activities are centered on advancing the state of medical science, technologies, and practices in those areas of most pressing need to today's battlefield experience. The Department's major contributors to advancing military medicine are the Defense Health Program, DARPA, Army and Navy. Through the Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee, co-chaired by DDR&E and the Assistant Secretary of Defense(Health Affairs)[7], the Department ensures coordination and collaboration across the organizations contributing to the program. For FY 2011, the program will continue to have major investment focus in ten areas which include: psychological health, traumatic brain injury, prosthetics and rehabilitation, restorative eye-care, poly-trauma, medical radiobiology, medical information systems, medical training systems, and infectious diseases. Some examples of new wounded warrior efforts are: three Research Consortia for the study of the prevention, diagnosis and treatment of TBI/PTSD; two clinical trials on face reconstruction; innovations in photomedicine technology for eye injury and wound infection control; initiation of pilot programs to exchange health data with the US Department of Veterans Affairs and private health care systems; initiatives by the MIT Institute for Soldier Nanotechnology to map brain activity with varying sensory and motor stimuli; regenerative medicine initiatives aimed at restoring limb and organ function; investigation of the intersection of the physics of blast and the neurobiology of brain injury in blast environments; and development of improved control and fit of prosthetic arm devices.

Cyber Operations Research

Deputy Secretary of Defense Lynn recently highlighted the critical nature of the cyberspace domain by stating, "The Defense Department has formally recognized cyberspace for what it is - a domain similar to land, sea, air and space. A domain that we depend upon and must protect." [8] Furthermore, the QDR identifies the need to improve our capabilities to counter threats in cyberspace. Our military forces require resilient, reliable networks to conduct effective operations. The number and sophistication of cyber threats are rapidly growing, and the urgency and criticality of improving cyber security has become a national security priority. Many studies have documented the threats and the inadequacy of current approaches to the increasingly sophisticated adversaries. The problem is complex and asymmetric -- attackers often need to find just one vulnerability while the defenders must currently defend everywhere with multiple approaches. In order to meet the challenge of defending against and defeating the threat, new thinking and new research ideas are needed to build a more resilient and trustworthy cyberspace. Our cyber defenses must provide worldwide operational mission assurance during cyber attacks. Cyber network operations are an emerging warfare area and to succeed, our cyber defenses require sustained, innovative research to address the

[7] The ASBREM also includes the Surgeons General of the Services and Joint Staff

[8] U.S. Department of Defense, *Remarks at the Defense Information Technology Acquisition Summit As Delivered by Deputy Secretary of Defense William J. Lynn, III (Washington, DC),* http://www.defense.gov/Speeches/Speech.aspx?SpeechID=1341 (Nov. 12, 2009).

constantly changing threats. DDR&E has advocated, driven, and coordinated efforts across the DoD for increased S&T in cyber security to develop enduring solutions to secure future military information systems.

Over the past few years DDR&E has brought together the DoD cyber research community to determine the DoD cyber S&T needs and priorities. Last summer, in response to the President's Cyberspace Policy Review, the Intelligence Advanced Research Projects Activity (IARPA) Director, Dr. Lisa Porter, and I launched a joint study in this area to identify high-payoff technology initiatives. This study, which was conducted with leading outside experts in the cyber security community, identified key areas of new research. These technology nuggets included new research to enable networks to operate through attacks, to establish security architectures for the many new mobile network devices, and to make the systems on our networks more difficult to find and target. Other new technology approaches were identified in virtualization to isolate untrusted programs, closed-loop software repair, and a new reference model for trusted computing. This and other studies, both classified and unclassified, have led to the development of a DDR&E new start program in Cyber Security Applied Research and Advanced Development.

The PBR-11contains two new, proposed DDR&E program elements to initiate a $200 million program over 5 years in applied research and advanced technology development for full spectrum computer network operations (CNO). This program will fund and transition the new research results. As the focus of the program, we have identified novel ideas to address the urgent S&T gaps in preparing for cyber conflict. The research problems are complex and joint, requiring the combined efforts of the Services and agencies. DDR&E has developed governance approaches that will insure a community-wide approach.

The DDR&E sponsored research will focus on developing new capabilities to:harden key network components; increase the military's ability to fight and survive during cyber attacks; disrupt nation-state level attack planning and execution; measure the state of cyber security; and explore and exploit new ideals in cyber warfare.

Through S&T investment in these areas, DDR&E will develop options for future capabilities to reduce vulnerabilities, reduce attack consequences, and reduce the threat from potential adversaries. While the details cannot be discussed in this forum, members of my staff have actively engaged with your Committee staff to describe the initial and ultimate plans for this program. We are committed to maintaining this visibility.

As part of the Comprehensive National Cybersecurity Initiative, DARPA is developing the prototype National Cyber Range (NCR). The National Cyber Range is envisioned to be a scientifically rigorous and realistic cyber testing platform. The NCR is intended to become a national resource for experimentation and testing of technology for both unclassified and classified cyber programs enabling leap-ahead advances in the US cyber capability. Upon completion, DARPA intends to transition this capability to broader use. Discussion of the transition strategy is ongoing.

The DDR&E staff has also played leading roles in the federal cyber security S&T planning and coordination. DoD laboratories are working with their civilian counterparts to support national efforts to secure cyberspace. These efforts contributed to the President's Cyberspace Policy Review, the National Cyber Leap-Year Summit, and the ongoing development of a federal cyber security research and development plan.

DDR&E has facilitated coordination and collaboration across the Services, DARPA and NSA by leading Steering Councils for both Cyber Security and Computer Network Operations S&T. DDR&E plans to use these groups as a mechanism to draw from technical resources across the entire Department. Coordination within these groups will ensure the Service laboratories, agencies, and partners executing the program work collaboratively to develop a robust portfolio of potential solutions to the large and complex problem of securing our networks and information systems. Looking forward, DDR&E will continue its facilitation role with other federal departments, agencies and international partners to more fully address the cyber security and information assurance challenges.

Electronic Warfare (EW) Technology Task Force

I chartered the Electronic Warfare (EW) Technology Task Force in response to concern that a common denominator among current and potential adversaries is a determined strategy to expand capabilities in the electromagnetic spectrum domain for offensive and defensive purposes. The mission of the EW Technology Task Force is to assess the military implications of the ubiquitous availability of high performance analog, digital, electro-optical, radio frequency and signal components, high performance signal and data processors, and increased ability to create sophisticated algorithms that will enable these systems.

The trend is clear: globalization of advanced electronic technology has made it easier for adversaries to develop effective EW capabilities, especially in a domain that is becoming increasingly congested by commercial competition for use. Additionally, we are seeing the convergence of underpinning technologies in areas such as space, cyber, electronic warfare and communications – areas traditionally considered to be independent. As a result, it will become more challenging and expensive for us to develop counter-capabilities if we continue to constrain ourselves to traditional development and acquisitions approaches and processes.

We must not only develop new concepts and capabilities to control and dominate the electromagnetic spectrum domain, but we must also be equally agile in fielding those capabilities. Success is crucial to the effectiveness of our forces. The EW Task Force findings are a first step in helping us identify potential solution paths.

Reduce the Cost, Acquisition Time and Risk of our Major Defense Acquisition Programs

In direct response to the Weapons Systems Acquisition Reform Act of 2009 (WSARA)[9], upon my arrival in DDR&E, the organization underwent a significant reshaping to more effectively address systems engineering, and developmental test and evaluation activities. USD(AT&L) Ash Carter recently testified that: "I support, as does the Secretary, the initiatives the Congress directed when it unanimously passed the Weapon Systems Acquisition Reform Act (WSARA) of 2009. Acquisition reform is one of DoD's High Priority Performance Goals presented in the Analytic Perspectives volume of the President's FY 2011 Budget. The Department is moving out to implement these initiatives." The following is how we are implementing WSARA as part of DoD's Acquisition Reform goal.

2009 Weapons Systems Acquisition Reform Act (WSARA)

The WSARA directed improvements on how the Department acquires major weapons systems in support of the warfighter. To that end, I have realigned the DDR&E organization to better staff and execute the necessary activities with the goal of ensuring that we, as a Department, reduce the cost, acquisition and time of delivery. Our Systems Engineering (SE) and Developmental Test and Evaluation (DT&E) Directorates are ensuring that the Defense Acquisition Board, Chaired by Dr. Ashton Carter, USD(AT&L), has relevant information prior to every milestone decision for MDAPs. Per WSARA legislation, our SE Directorate has also initiated a formal Development Planning framework to ensure we have a solid R&E foundation well before milestone A, and prior to the formal program initiation. The Development Planning process will mature over the next few months and will become a formal practice for all new acquisition programs.

WSARA vests new authorities and responsibilities in the Systems Engineering Directorate. It expands the sphere of oversight to include both systems engineering and development planning policy and guidance and adds the use of systems engineering approaches to enhance reliability, availability, and maintainability on MDAPs. Additionally, SE authorities for development and approval of Systems Engineering Plans (SEPs) were expanded to include oversight of all MDAPs. SE is currently defining application of development planning across the acquisition lifecycle, with particular emphasis on pre-Materiel Development Decision and Materiel Solution Analysis phase technical assessments to enable sound cost and schedule estimation of the preferred system solution presented to the Milestone Decision Authority at milestone A.

WSARA directs the SE and DT&E Directorates jointly submit an annual report to the congressional defense committees on the activities undertaken during the preceding year relating to each MDAP, which will include the program's fulfillment of the

[9] "Weapon System Acquisition Reform Act of 2009" (PL 111-23, 22 May, 2009)

prescribed objectives for the past year. The first annual report also includes analysis of Service SE and DT&E efforts and workforce.

Systems Engineering

Systems engineering is the interdisciplinary application of engineering tools, analysis, and techniques in a systems context. In all its activities, SE employs processes intended to reduce the cost, acquisition time, and risk of acquisition programs and to support the ultimate goal of delivering superior capability to the warfighter to prevail in current and future conflicts. It focuses on defining customer needs and required functionality early in the development cycle, documenting those requirements, and then proceeding with a structured process of design synthesis and system validation while considering the complete problem..

SE conducts detailed program reviews using a consistent, repeatable methodology (the Defense Acquisition Program Support Methodology) to advise program managers on risk and to provide mitigation recommendations, to inform DoD leadership of technical and engineering risks, and to provide milestone decision recommendations to USD(AT&L).

Emphasizing Early Life Cycle Systems Engineering

In accordance with WSARA direction, DDR&E is leading an effort to establish a Development Planning capability across the Department, and to establish technical leadership, authority, and engagement in the very early conceptual stages of the acquisition lifecycle. Development Planning comprises the upfront technical preparation to ensure the successful selection and development of a materiel solution. Development Planning policy, guidance and oversight, applied during early phases of acquisition, beginning with the Materiel Development Decision, will establish the foundation for our acquisition programs, and bootstrap our requirements and analytical processes with the engineering and technical engagement.

Developmental Test and Evaluation (DT&E)

DT&E is responsible for policy and guidance for the conduct of developmental test and evaluation in DoD. DT&E works closely with the Office of the Director, Defense Procurement and Acquisition Policy (DPAP) and the Office of the Director, Operational Test and Evaluation (DOT&E) to develop formal content. The policy and guidance are published in the Defense Acquisition Guidebook (DAG) and in DoD directives and instructions such as the Department of Defense Instruction (DoDI) 5000.02, “Operation of the Defense Acquisition System.”

During FY 2009, DT&E engaged on the above-mentioned policy and guidance development in addition to publishing the guide Incorporating Test and Evaluation into DoD Acquisition Contracts, the Test and Evaluation Master Plan (TEMP) Guide, and the evaluation framework used for TEMPs. In addition, existing documentation includes policy and guidance on test and evaluation (T&E) for joint Military Departments and Agencies to support systems that provide capabilities for missions that must be tested in a

joint operational environment. Moreover, DT&E serves as Vice Chair to DoD's Testing in a Joint Environment Senior Steering Group, a formal governance body to oversee the implementation of the DoD Testing in a Joint Environment Roadmap.

According to statute and policy, DT&E reviews and jointly approves the TEMPs and Test and Evaluation Strategies (TESs) for all MDAPs and other programs on the OSD T&E Oversight List in coordination with Director, Operational Test and Evaluation (DOT&E). DT&E also coordinates with SE to ensure DT&E activities are integrated and consistent with systems engineering and development planning. Since July, the office has approved 23 TEMPS and assisted component test development planning on 76 programs. Efficient, well-planned test programs are essential for rapid fielding capability in support of current operations.

Technology Readiness Assessments

The final element of the WSARA legislation was the expansion of the application of Technology Readiness Assessments (TRAs). In recent years, there has been increasing recognition, both inside and outside of the Department, that efforts to begin system development with immature technologies incur higher risk. The DoD, Government Accountability Office, and Congress have all recognized the fundamental role that mature technologies play in defense acquisition program success.

Technology Readiness Assessments have been used by USD(AT&L) to support DoD acquisition decision-making, and to certify technology maturity at Milestones B and C, and they have been effective in the identification of technology readiness issues prior to acquisition decision points, thereby focusing attention on mitigating any such deficiencies. In some cases, immature technologies have been identified that led to additional technology testing and validation in operationally relevant environments. TRAs have also clarified ambiguities in system requirements that might otherwise cause serious problems and delays during program execution. Lessons on how to conduct more effective assessments are being continually learned from past assessments, and are captured in the TRA Desk Book to assist current and future acquisition programs.

During calendar year 2009, DDR&E completed 11 TRAs of MDAPs, and 1 special assessment. Numerous other TRAs progressed at various stages of the rigorous process employed by DDR&E and Service Acquisition executives. Among the MDAPs assessed were Standard Missile-6 (SM-6), Warfighter Information Network-Tactical (WIN-T), and Joint Tactical Radio System Wideband Networking Waveform (JTRS WNW). In every case, an Independent Review Team (IRT) serves as a key element of the TRA process. The IRT is charged with identifying critical technology elements, and objectively evaluating evidence of technological readiness relative to the specific requirements of the MDAP in question. IRT results are then carefully evaluated by DDR&E, and the results are used to shape upcoming acquisition decisions. As a result of WSARA direction, DDR&E will expand the use of TRAs to conduct periodic examinations of selected MDAPs that passed Milestone B three or more years previously to ensure prompt visibility into potential risks associated with technology maturity.

Develop World Class Science, Technology, Engineering, and Mathematics (STEM) Capabilities for the DoD and the Nation

Preparing the Department to manage complex science and technology challenges requires building and shaping a highly-qualified science, technology, engineering and mathematics (STEM) workforce. This drives DDR&E's fourth imperative: to develop necessary STEM capabilities for the Department and the Nation.

To provide context and to initiate thought leadership for this imperative, DDR&E convened a STEM Board of Directors consisting of 27 senior leaders from across the Department. One of their first activities was to guide the development of a STEM strategic plan for the Department. The STEM Board of Directors' charter is to inspire, develop and attract the talent in STEM disciplines essential to deliver innovative solutions for the Nation's current and future challenges. The strategic plan is intended to guide the series of initiatives that support the DoD STEM program portfolio, and respond to the short-, medium- and long-term STEM needs of the Department across the Services and components.

National Defense Education Program (NDEP)

To augment the policies of the STEM Board of Directors, we have increased our FY 2011 President's Budget Request for the National Defense Education Program (NDEP). NDEP codifies and funds authorities granted in the FY 2005 Authorization Act.

In 2009, the Science, Mathematics And Research for Transformation (SMART) program provided full scholarships to 250 high-performing STEM students who will come work for the DoD immediately after they graduate. By the end of this year, nearly 300 SMART students will have transitioned to DoD laboratories and other components.

NDEP's K – 12 component contributes to enhancing teacher quality in STEM and increasing student involvement in science and engineering activities. DoD laboratory scientists and engineers work with classroom teachers and their students in their local communities.

The third component of NDEP, the National Security Science and Engineering Faculty Fellowship (NSSEFF) supports U.S. investments in basic research and creates collaboration between academia and the government. Since 2008, the NSSEFF program has made awards to 29 high-performing distinguished faculty to conduct revolutionary research that is critical to the DoD and national security. Two important features of NSSEFF that are providing additional benefit to DoD are the direct engagement of Fellows and their teams of undergraduate, graduate and and post-doctoral scholars with our scientists and engineers; and the inclusion of these talented technical teams in DoD research-focused workshops.

Historically Black Colleges and Universities / Minority Institutions (HBCU/MI) Program

The DoD Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) program is designed to inspire young people to pursue studies and careers in science, technology, engineering and mathematics to address future national security challenges.

Through the HBCU/MI program, DoD not only supports promising research at these institutions but also seeks to increase the cadre of individuals that pursue STEM disciplines as a career. Graduates of these institutions contribute to diversity in this pool nationwide across the research sector. Some graduates, including those who have had had an opportunity to participate in DoD programs through research opportunities at DoD laboratories as part of the HBCU/MI program, may become DoD employees.

For the 2 year period ending in July 2009, DoD provided funding for more than 460 undergraduate and graduate students at HBCUs/MIs. Of that number, almost 30 percent graduated with degrees in STEM and many of them expect to pursue graduate or post-graduate work. Some expect to work for DoD, while others will pursue STEM careers in other research settings. An example of the above is the John Hopps Defense Research Scholars program at Morehouse College, which currently supports 100 STEM students. The first class of 20 scholars under this program will graduate in May 2010.

A Look Ahead

Beyond the FY 2011 President's Budget Request, we are beginning to frame concepts in two key areas that will have critical importance for the Department and for our Nation in the next decade. We are polling the user and technical community to frame future efforts in 'Data-to-Decisions' and 'Systems 2020' that are needed to address aspects of all of the QDR mission areas.

Data-to-Decisions

The purpose of this initiative will be to develop technologies to manage the massive data sets being piped around our operational theaters while also providing actionable decision tools for our leadership. Recently Lieutentant General Dave Deptula, the Air Force Director of Intelligence recognized, "we are swimming in sensors and drowning in data"[10]. New sensing capabilities are now emerging that generate significantly more data than all our currently fielded UAVs combined. The S&T community has been successful in giving our forces a data advantage; now the challenge is to deliver a decision advantage. We will examine handling, fusing and exploitation of these massive data sets and other innovative approaches for the distribution, storage and efficient retrieval schemes. Our goal will be to advance data analytics to allow data to be fused with relevant contextual or situational information to provide our warfighters and decision makers with insight and powerful decision aids.

[10] LtGen David Deptula, USAF. (2009). Speech content. October 2009. *C4ISR Journal* Conference, Arlington, VA

Systems 2020

The second overarching initiative – Systems 2020 – is designed to give the DoD S&T and manufacturing communities a decisive edge in the design and manufacture of complex systems. Over the past years, the Department's research and development efforts have successfully resulted in the delivery of high performance software and hardware components, but at a cost of increasing system complexity. Like the commercial sector, the DoD needs to adapt to the growing complexity of our major acquisition systems while managing cost, schedule and performance risk throughout the lifecycle. These very complex systems must be adaptable to changing environments and interoperable with other fielded systems to ensure optimum delivery of capability to our warfighters and value to our taxpayers. The Systems 2020 initiative will be a Department-wide effort to develop new system engineering foundations for the next decade in basic research, applied research, prototype development, and workforce development. When realized, the new tools and processes will enable a number of new design, development, and manufacture capabilities across the DoD acquisition enterprise.

Summary

With the support and guidance from our DoD leadership and Congress, we have made significant progress reshaping the Department's research and engineering enterprise using the coordinates of innovation, speed and agility as our metric. We have teamed with industry, academia and our own DoD laboratories to form the Research Triple to ensure our most talented technical minds are addressing the technology challenges currently posed by our Warfighters while remaining adaptive to future requirements. Within this context, the FY 2011 President's Budget Request for science and technology was developed to support Department-wide efforts to provide technological solutions, identify strategic threats and develop improved capabilities is critical in support of our national security. To maintain our technological advantage on the battlefield, we have reinvigorated STEM initiatives and programs designed to inspire, develop and attract the talent essential to deliver these innovative solutions. The combination of first rate people and compelling ideas will continue to drive our innovative engine and ensure our Nation continues to maintain a competitive edge on the battlefield. Thank you for the support of the DoD S&T enterprise and I appreciate this opportunity to provide the committee with an update on the status of the DoD S&T enterprise.